Section of the History of Medicine

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Medical Aspects of Polar Exploration: Sixtieth Anniversary of Scott's Last Expedition

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State of Knowledge About Scurvy in 1911

I should like to discuss the state of nutritional knowledge with regard to scurvy in 1911, and consider whether Scott was as up-to-date as he might have been. Let us look at Scott's base in the winter of that year. Cherry Garrard had safely returned from Cape Crozier after the small party had made the 'worst journey in the world'. At base, there were preparations since the darkness of May for spring journeys. There would be choir practice and evening lectures – by the glaciologists, geologists; Herbert Ponting would talk about Japan, showing his hand-tinted pictures with the magic lantern. Dr Edward Wilson spoke on penguins, and Dr Atkinson, having given one lecture on parasites, gave another on scurvy. Here is the entry in Scott's diary:

'As the daylight comes, people are busier than ever. It does one good to see so much work going on.

'Friday, August 18 – Atkinson lectured on "Scurvy" last night. He spoke clearly and slowly, but the disease is anything but precise. He gave a little summary of its history afloat and the remedies long in use in Navy.

'He described the symptoms with some detail. Mental depression, debility, syncope, petechiæ, livid patches, spongy gums, lesions, swellings, and so on to things that are worse. He passes to some of the theories held and remedies tried in accordance with them. Sir Almroth Wright has hit the truth, he thinks, in finding increased acidity of blood – acid intoxication – by methods only possible in recent years.

'This acid condition is due to two salts, sodium hydrogen carbonate and sodium hydrogen phosphate; these cause the symptoms observed and infiltration of fat in organs, leading to feebleness of heart action. The method of securing and testing serum of patient was described and the test by litmus paper of normal or super-normal solution.

'Lactate of sodium increases alkalinity of blood, but only within narrow limits, and is the only chemical remedy suggested.

'So far for diagnosis, but it does not bring us much closer to the cause, preventives, or remedies.

'In brief, he holds the first cause to be tainted food, but secondary or contributory causes may be even more potent in developing the disease. Damp, cold, over-exertion, bad air, bad light, in fact any condition exceptional to normal healthy existence. Remedies are merely to change these conditions for the better. Dietetically, fresh vegetables are the best curatives – the lecturer was doubtful of fresh meat, but admitted its possibility in Polar climate; lime juice only useful if regularly taken. He discussed lightly the relative values of vegetable stuffs, doubtful of those containing abundance of phosphates such as lentils. He touched theory again in continuing the cause of acidity to bacterial action – and the possibility of infection in epidemic form. Wilson is evidently slow to accept the "acid intoxication" theory; his attitude is rather "non proven". His remarks were extremely sound and practical as usual. He proved the value of fresh meat in Polar regions.

'Scurvy seems very far away from us this time, yet after our *Discovery* experience, one feels that no trouble can be too great or no precaution too small to be adopted to keep it at bay. Therefore such an evening as last was well spent.

'It is certain we shall not have the disease here, but one cannot foresee equally certain avoidance in the southern journey to come. All one can do is to take every possible precaution.'

In fact, three years after the *Discovery* expedition, he wrote (Scott 1905):

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'We found no events that definitely contributed to Scurvy and the surprise of the unpleasant discovery has not lessened by the passage of time. Till recently we felt that the antidote lay with vegetable acids – scurvy grass and finally lime juice is a legal necessity on ships away for long periods . . . but I understand now that Scurvy is believed to be ptomaine poisoning caused by the virus of the bacterium of decay in the meat. And in plain language, as long as man continues to assimilate the poison, he is bound to become worse . . . the practical point is therefore to obtain meat which does not contain this poison . . . difficult because the danger lurks everywhere. It may be in a tin of meat that by sight and smell is in perfect condition. The rough guide is a "blown" tin . . .'

This obsession with the ptomaine theory caused Scott to set great store on examination of tins – but for what? He wrote further:

'For the Winter routine we had seal meat twice a week, and mutton once; and tinned meat on the remaining days. Which of these gave us the Scurvy? It is a great pity for medical science that we could not study the question. Food on Arctic expeditions should be chemically analysed. . . . But fortunately, in the Antarctic, there is fresh food for the catching by wintering parties. . .'

However, the criticism has been made that Scott's prejudice against the slaughter of seals meant too great a reliance on tinned meat.

On the *Discovery*, Dr Koettlitz had, in fact, grown mustard and cress, but in too small quantities to have much impact one way or another, and the theory most in vogue at that time was that scurvy was due to ptomaines developed in poisoned meat. *The Times*, in 1904, commented drily: 'Nobody knows what ptomaines are or how they got there. The old faith in fresh vegetables is being exploded.'

Captain Scott could hardly be expected to refute this theory, when one considers how formidable was the protagonist – Sir Almroth Wright.

Sir Almroth Wright was responsible for the development of active immunization against typhoid fever. He had been professor of pathology at the Army Medical School, and was knighted in 1906. He was a man of massive authority and great intellect. He devised a technique to measure the phagocytic activity of a patient's blood. This provided an 'opsonic index' and it features in Bernard Shaw's 'Doctor's Dilemma'. He was a friend of Shaw's, and Shaw wrote the play round him, and if truth be known, G B S was about the only man who could out-talk him. In 1895 and 1900, Almroth Wright published two papers on the pathology and therapeutics of scurvy, in which he argued that the condition was due to acid intoxication. He accepted that fresh meat could ward off scurvy, but the clinical treatment would consist of the administration of easily oxidizable organic salts to provide the bases removed from the body by the scorbutic process.

He accepted also that fresh vegetables and lime juice were useful only because, on combustion, they yielded an alkali ash and this neutralized the acid intoxication.

The idea that there might be deficiency diseases had not been aired. Gowland Hopkins's paper appeared in 1906, but when Scott was preparing for the 1911 expedition there was nothing tangible for him to go on, except perhaps for the new scientific concept that accessory food factors could exist.

If nutritional science could not help Scott, let us see how history might have guided him. In 1847–59, McClure's expeditions, provisioned with 'lime juice', were immune from scurvy; but in 1875, Nare's expedition, also provisioned with 'lime juice', suffered badly, and a distrust of 'lime juice' developed. The experiences on the Jackson-Harmsworth expedition further increased this distrust, and encouraged the ptomaine theory: the sledgers having fresh meat were unaffected; the ship party, eating tainted, salted meat, were heavily involved with scurvy, which enhanced the ptomaine poisoning theory. In 1911 Scott, remembering the scurvy on the *Discovery* expedition, would get no clear lead from the history of polar exploration.

And yet, if one goes back a hundred years, the story was dramatically different.

It will be recalled that in the long history of scurvy – described by Hippocrates – many theories were offered for its cause: climate, storms, unwholesome food, badly regulated work and exercise. The evidence was always there but James Lind was the first to pinpoint the crux of centuries of observations; in 1747, he did a most impressive clinical trial:

'On the 20th of May 1747, I took twelve patients in the scurvy, on board the *Salisbury* at sea. Their cases were as similar as I could have them. They all in general had putrid gums, the spots and lassitude, with weakness of their knees. They lay together in one place, being a proper apartment for the sick in the fore-hold; and had one diet common to all. . . . Two of these were ordered each a quart of cyder a-day. Two others took twenty-five gutts of *elixir vitriol* three times a-day, upon an empty stomach; using a gargle strongly acidulated with it for their mouths. Two others took two spoonfuls of vinegar three times a-day, upon an empty stomach; having their gruels and their other food well acidulated with it, as also the gargle for their mouth. Two of the worst patients, with the tendons in the ham rigid . . . were put under a course of sea-water. Of this they drank half a pint every day, and sometimes more or less, as it operated, by way of gentle physic. Two others had each two oranges and one lemon given them every day. These

they eat with greediness, at different times, upon an empty stomach. They continued but six days under this course, having consumed the quantity that could be spared. The two remaining patients, took the bigness of a nutmeg three times a-day, of an electuary recommended by an hospital-surgeon, made of garlic, mustard-seed, *rad. raphan.* balsam of Peru, and gum myrrh; using for common drink, barley-water well acidulated with tamarinds...

'The consequence was, that the most sudden and visible good effects were perceived from the use of the oranges and lemons; one of those who had taken them, being at the end of six days fit for duty... The other was the best recovered of any in his condition; and being now deemed pretty well, was appointed nurse to the rest of the sick' (Lind 1753).

When Captain Cook set out on his second expedition in 1771, he tried to get Lind to join him, but this fell through; at least, he took Lind's teachings and demonstrated their value in practice. It will be recalled that Cook went to complete the discovery of the southern hemisphere. He did not succeed in this, but, as he wrote in 1777:

'Whatever the public judgement, it is with satisfaction that I can conclude that our having discovered the possibility of preserving health of the ship's company for such a length of time, in such varieties of climate, hardships and fatigues will make this voyage remarkable, when the disputes about a Southern Continent shall have ceased to engage the attention and divide the judgement of philosophers.'

It was for maintaining the long voyages without a single death from scurvy that he was given the Copley Medal of the Royal Society.

It was another twenty years before the Navy adopted Lind's teaching – in fact, in 1795, a year after Lind's death. It should be remembered that by the end of the eighteenth century, they had wiped out scurvy. Cook had evolved a system which included not only the ration of 'lime juice', fresh food and vegetables wherever possible, but also clean quarters and attention to hygiene. When this system was not rigidly complied with, scurvy occurred. And once on Cook's expedition, in the *Adventure*, under Captain Furness, there was a degree of slackness which led to the disease; but Cook's ship, the *Resolution*, remained free of disease.

For the Navy, there were obvious advantages of freedom from scurvy.

They benefited greatly because their fighting strength was doubled without adding a penny to the naval estimates, or a man to the total strength. There was the spectacle of the English ships blockading the French coasts and being able to remain at sea continuously if they had fresh food and vegetables. But the merchant crews of the supply ships were decimated by scurvy whilst carrying the antiscorbutics they were not allowed to touch (Dudley 1953).

It might be supposed that this would mark the end of scurvy. But in fact the strict routines were disobeyed and even forgotten; so that when we look at the record in the nineteenth century, there is nothing but confusion, and Captain Scott in 1911 can be excused for being sceptical of 'lime juice'.

Let us examine the situation when Shackleton prepared for the Imperial Transantarctic Expedition in 1913. He had, of course, been a member of Scott's *Discovery* expedition; he had suffered from scurvy; he was not impressed with the toxic theory, but showed a greater interest in the value of fresh food, and a system of hygiene like Captain Cook's. However, it was difficult to believe in an absolutely reliable system because it was common experience that the 'lime juice' was of doubtful value.

None the less, the vitamin theory had been established. After Gowland Hopkins, the Norwegian workers Holst & Frölich (1907) did the first systematic work on experimental scurvy: they showed that it could be induced in guinea-pigs by removing green stuff and giving a diet of grain and water only. In 1912 they showed that dry cereals could not prevent scurvy (Holst & Frölich 1912), but after soaking and germinating, they acquired anti-scurvy properties. (This had in fact been anticipated in 1782; and on the *Discovery* expedition, Dr Koettlitz had taken pulses which he grew.)

At the Lister Institute, work was starting on the antiscorbutic properties of various foods, and how to concentrate the active principles without destroying them. The failure of 'lime juice' was now attributed to the high temperature used in concentration and oxidation. Shackleton familiarized himself with all this technology and arranged for lime juice concentrates to be anaerobically prepared and put up in a daily dose per capsule. Essentially though, Shackleton did not rely on a single preparation, but on a well-balanced diet with adequate calories. There was no scurvy on the Weddell Sea part of the expedition; but after the loss of the *Endurance* there was a small party which did suffer from scurvy on their journey to wait for Shackleton at Cape Evans. It was soon cured with fresh seal meat; and it would seem that if lime juice capsules were available, they were not adequate.

One cannot conclude this story of scurvy in polar exploration without clearing up two mysteries:

(1) Whatever happened to the high promise that 'lime juice' had in the eighteenth century, and

why did it fall into disrepute in the middle of the nineteenth century?

This mystery was brilliantly resolved by Alice Henderson Smith (1918) who traced the events from the beginning of the nineteenth century. As we know, by 1810, in the Royal Navy, all records of scurvy cease. It turns out that 'lime juice' was a misnomer – it referred actually to the juice of lemons. They came from Spain, but in 1796, as a result of the war, they then came from Lisbon, but here the supply was uncertain, and the source was once again switched, this time to Malta and Sicily. The supply was now good enough to allow it on general ration instead of only for the sick and on foreign voyages.

By the middle of the nineteenth century, there were complaints of the quality of the Malta lemon; the Admiralty wanted to take no chances, especially with the Arctic ships, so they made new arrangements. The West Indies were now growing limes, produced by English firms there, who could be relied on for high standards of fruit production. By now, it was thought that the antiscorbutic virtue lay in the acidity, and reports were coming that West Indian limes were of high acidity. The Admiralty transferred its contracts, and by 1870 very little real lemon juice was supplied.

In 1847–59, McClure's ships were immune from scurvy because they had real lemon juice, although called 'lime juice'. Nare's expedition in 1875 suffered from scurvy because they had the juice of West Indian limes. It was, in retrospect, an excellently controlled experiment, but it merely added to the disrepute of real lemon juice. It was shown years later that the West Indian lime juice contained barely one-quarter of the ascorbic acid of mediterranean lemon juice. Thus, for all Shackleton's precautions, had he relied entirely on the capsules of juice, he would have had trouble with scurvy (Medical Research Council 1932).

(2) Whatever happened to the acid intoxication theory of scurvy? Almroth Wright clung doggedly to his theory, although it turned out to be a symptom of the disease rather than the basic cause.

It was only in 1937, when Lewis Holt showed him that if scorbutic guinea-pigs were given pure crystalline ascorbic acid they were cured of experimental scurvy and that this substance could prevent the condition, that Wright capitulated.

There is nothing that does not confirm Captain Scott as a wise and meticulous leader, and a man of his time – no better, no worse. And those of us who have had medical responsibilities on polar expeditions are extremely humble and grateful that in our day we do not have the agonizing lack of knowledge in these matters which applied half a century ago.

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The Logistics of the Polar Journeys of Scott, Shackleton and Amundsen

The problems of travel in Antarctica have been finally solved with the introduction of motor vehicles, tractors and support aircraft. Radio communication and modern methods of navigation have played a part by making it possible to maintain contact with small parties on the polar plateau and surrounding mountains, and to visit them at will.

But of more interest physiologically and medically are the journeys of Scott, Shackleton and Amundsen between the years 1901 and 1912, and my purpose is to consider these in the light of physiological information collected by a later generation.

I shall begin by summarizing the accounts of the respective expedition leaders. In comparing them it is well to bear in mind that neither Scott nor Shackleton had any experience of polar travel or living in snow when they first went to Antarctica with the *Discovery* expedition in 1901–03. Amundsen, on the other hand, was an extremely experienced explorer. He and his companions had been brought up to ski and travel on snow and were accustomed to a cold environment.